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Nuclear Safety Research Department Annual Progress Report 1990

Edited by F. Heikel Vinther

Risø National Laboratory, Roskilde, Denmark
July 1991

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Abstract. The report describes the work of the Nuclear Safety Research Department during 1990. The activities cover health physics, reactor physics, operation of the educational reactor DR 1, and waste management.

Lists of staff and publications are included together with a summary of participation in international working groups etc.

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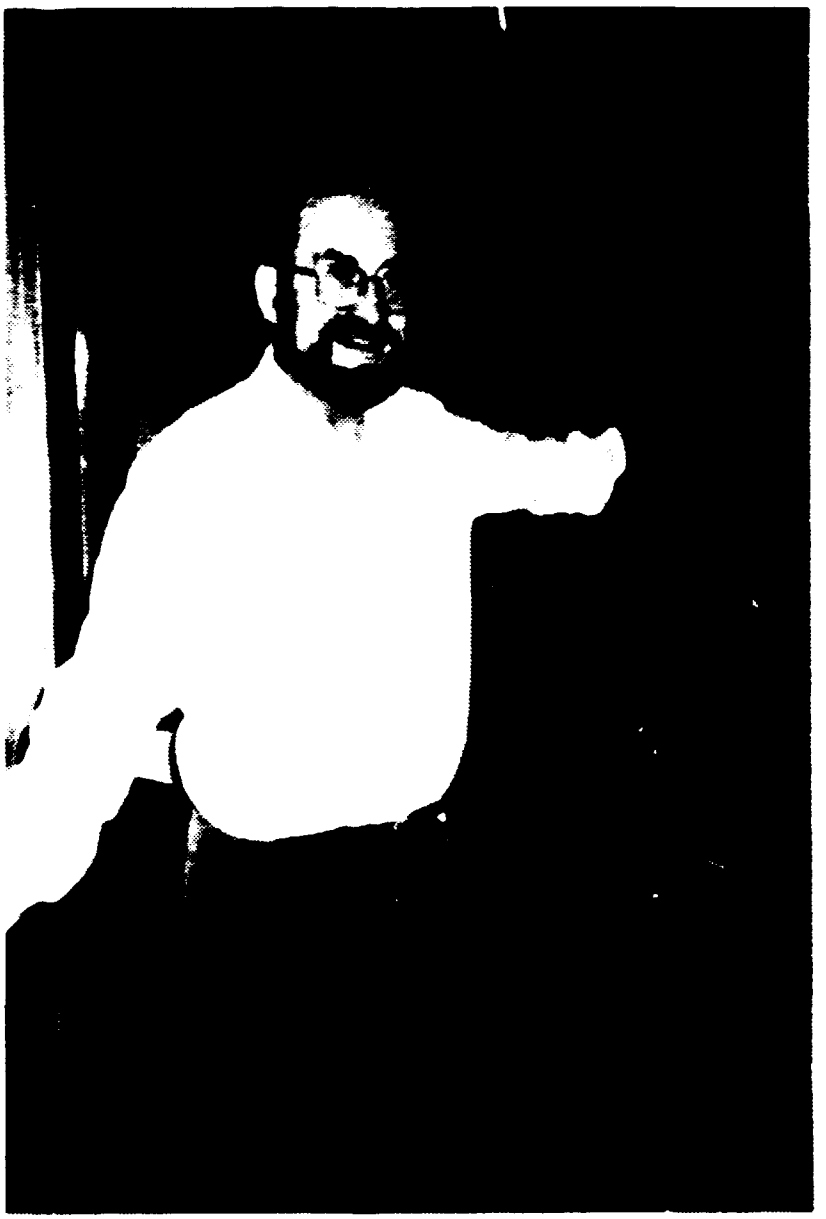

Bjarne Micheelsen 23.11.1932 - 27.8.1990

OBITUARY

The head of the Nuclear Safety Research Department Bjarne Micheelsen died unexpectedly 22. August 1990 at the age of 57. He was one of the leading personalities in Danish energy research.

After graduating as an engineer in 1957, Bjarne Micheelsen became one of Denmark's first reactor physicists taking part in heavy water reactor projects at Risø National Laboratory, in the OECD Dragon project, and in the building up of an LWR expertise in Denmark. In 1968 he became the leader of Risø's Reactor Physics Department. Since then, the department of which Bjarne Micheelsen was the leader, was united with others, renamed or split up, reflecting the changing priorities in Danish energy policy.

Bjarne Micheelsen did not always approve of these changes, one of which rejected the nuclear option for Denmark. All the same, he actively supported research in wind energy, combustion technology and oil and gas reservoir technology as well as energy systems analysis.

Bjarne Micheelsen was active in the Nordic collaboration and in a number of international committees in the OECD and in the EEC.

And last but not least, Bjarne Micheelsen loved sailing, music - especially operas, and a merry company with friends and colleagues.

1. INTRODUCTION

In March 1990, Risø National Laboratory underwent a major reorganization. A Nuclear Safety Research Department was established comprising part of the earlier Health Physics Department, the Waste Management Section, and the Section of Reactor Physics with the Reactor DR 1. However, the Radioecology Section of the Health Physics Department was made part of the new Environmental Science and Technology Department.

The object of this constellation was to concentrate in one department all of Risø's commitments in the nuclear field and the research needed to fulfil them.

The present report describes the work through 1990 of the Nuclear Safety Research Department. Included is also the scientific work of the staff of the Section of Applied Health Physics, which is part of the Safety Department.

2. SECTION OF HEALTH PHYSICS

2.1. Modelling of Atmospheric Dispersion

Work continued on development of computer models for the dispersion of harmful (toxic) materials in the atmosphere. Efforts were concentrated on the RIMPUFF model (RIsø Mesoscale PUFFmodel), which is able to cope with weather conditions which change in time and space. In 1990 this model was evaluated using two complex terrain experiments: the Swiss SIESTA experiment and the Guardo experiment, which was performed in northern Spain. As the two experimental sites were situated in mountainous terrain, RIMPUFF was coupled with the fast high resolution mean flow-model LINCOM. The results of these model evaluations seem satisfactory and will be published in 1991.

A contract was signed with the CEC concerning the implementation of RIMPUFF within a coming European system for real-time calculation of the consequences of nuclear accidents. It is intended that RIMPUFF should be used within this system as a mesoscale atmospheric dispersion module.

Aujeszky's disease is a serious problem for Danish farmers and a considerable effort is put into the work of preventing the spread of this disease. Therefore a "real-time" system for calculating the dispersion of virus from Aujeszky's disease is being developed in cooperation with the Danish Bacon and Meat Council. A meteorological mast was set up at Kegnæs in southern Jutland and a datalink between this mast and a computer at the headquarters of the Danish Bacon and Meat Council in Copenhagen is being established.

2.2. Assistance to the Danish Civil Defence Agency

Risø operates the Danish permanent monitoring system of potential radioactive contamination. The system was put into operation by December 1989. Data are collected from 11 measuring stations

distributed across the country and transmitted to a computer at Risø as well as a reserve computer at a Civil Defence location. Software for handling and presenting the data has been developed at Risø during 1990.

The monitoring system has shown good general stability, but a few points require some attention:

- some cases of minor damage have been reported from thunderstorm activity; installation of some overvoltage protection units are considered.

- a number of communication drop-outs has delayed the data-collection from parts of the country up to several hours. A remedy may be an extra line connection.

- some technical errors in the internal software for the multi-channel-analyzer have been repaired by the supplier.

Increases in the background dose rate are observed only after precipitation - due to wash-out of aerosol-carried radon daughters.

In a number of cases, background dose rates increased to up to 70% over normal level. This phenomenon was found to be related to special meteorological circumstances: a strong wind blowing over an extended period from the south-east changing to a westerly direction through a front passage with rain. Similar increases were observed in Norway and Sweden; trajectories calculated by the Norwegian Institute of Meteorology located the source of the higher radon gas levels to be somewhere in the central part of Europe - southern Germany, Austria, Czechoslovakia, and southern Poland.

On May 8 Risø participated in a Swedish-Danish Barsebäck emergency exercise "MY". As a result of this exercise, some modifications were entered into the ARGOS system, which is a computer-

ized system for communicating, presenting and storing monitoring data (Accident Reporting, and Guiding Operational System).

2.3. Participation in Nordic Co-operation

In 1990 a new Nordic four-year nuclear safety programme started. The Health Physics Section was entrusted with managing a project under the part of the programme concerned with nuclear preparedness. The project (BER-3) is titled: Evaluation and Harmonization of the Planning of Countermeasures and the Use of Intervention Levels. Under the project, a review was made of the work on intervention policy in international organizations during the last ten years. Simple illustrative examples on intervention level settings for relocation and foodstuff restrictions were derived from the optimization principle. A working group was established for the evaluation part of the project.

The Section of Applied Health Physics contributes to another Nordic project, BER-1, on dispersion and environmental consequences. Evaluations and comparisons are made on emergency preparedness concerning exposure from radioactive clouds and fall-out. Preliminary evaluations are carried out on shielding, relative exposure from deposition on various surfaces and the relative importance of various exposure pathways.

Within the framework of BER-1.1, Real-time Dispersion Modelling, a closer cooperation has been established between Risø, the Swedish Meteorological and Hydrological Institute (SMHI) and the Danish Meteorological Institute (DMI). Risø and SMHI are coupling the Risø mesoscale puff model (RIMPUFF) to the SMHI long range dispersion model (RAM). Methods for connecting DMI's HIRLAM flow model to RIMPUFF are being investigated by DMI and Risø. The aim of this work is to establish an integrated system for calculating the dispersion of toxic material over long (1000 km) and medium range. HIRLAM and RAM are used for calculating the long range dispersion, while RIMPUFF, using the windfield data from HIRLAM, will be used to calculate the dispersion on local/medium scale (100 km).

The work on the Nordic Chernobyl Data Base was continued with further software development. Instruction courses have been given to users in the other Nordic countries. A guest stipendiate has been working at Risø on preparing data from samples taken in various lakes and at sea.

The cooperation with The Swedish National Institute of Radiation Protection concerning emergency preparedness planning was continued. A contribution was made to the preparation of the scenario for a Swedish drill in December. A staff member participated in the drill itself.

A recalculation was done for a part of the safety documentation for the Swedish nuclear power plants Ringhals 3 and 4. The calculations concerned doses to the surroundings from a series of different theoretical accidents.

2.4. Dosimetry and Radon Investigations

2.4.1. Personal Dosimetry

Risø's personal dosimetry service covers the individual monitoring of the personnel at Risø and at the Niels Bohr Institute Tandem Accelerator. During the year, the procedure for issuing personal dosemeters was changed so that only persons actually involved with radiation work are issued with a personal dosemeter. For controlling the radiation levels in areas where the use of personal dosemeters is not required, an extensive environmental monitoring programme using TL dosemeters has been established.

In 1990 approximately 1900 persons were monitored; of these 153 persons received doses above the registration level for external doses of 0.2 mSv. The total dose (collective dose equivalent) registered to the monitored personnel was 0.25 man sievert which is the same total dose as that registrered in 1989. 59 persons

received internal doses caused by intake of tritiated water. The contribution to the total dose from internal doses was 0.008 man sievert. For 1989 the total internal dose was 0.013 man sievert. Figure 2.1. shows the distribution of the registered doses for 1990.

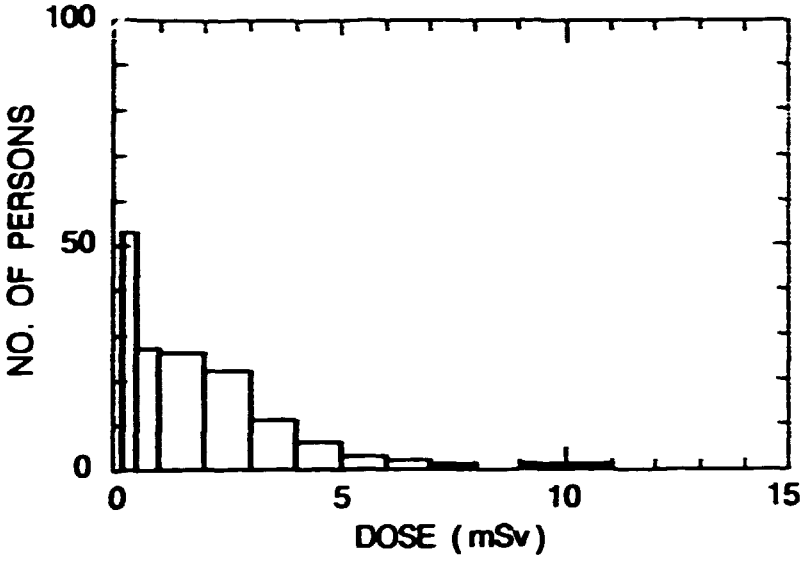

Fig. 2.1. Distribution of wholebody doses (effective dose) in 1990 for the Risø personnel.

The group has participated in the second phase of a co-ordinated programme of research in an "Intercomparison Programme for Individual Monitoring" aimed at developing simple calibration procedures that can be easily used worldwide. The programme is co-ordinated by IAEA and carried out under a research agreement.

The response of track detectors to neutrons of various energies and angles of incidence was further investigated through the participation in the Eurados-Cendos joint irradiation programme 1990. The results will be published in a joint report from Eurados-Cendos/PTB. During 1990 the previously used NTA films have been replaced by track detectors in routine personnel neutron dosimetry at Risø.

As part of the investigations on radiation doses to the population of Denmark due to the Chernobyl accident, monitoring continued on the content of cesium-137 in a selected group of Danes.

2.4.2. CEC Technical Recommendations on Individual Monitoring

Together with other laboratories, the dosimetry group has assisted CEC in preparing a document on technical recommendations for monitoring the exposure of individuals to external radiation. The document is intended to provide guidance for those 1) responsible for individual monitoring programmes, 2) operating monitoring services, 3) involved in dosemeter design, and 4) responsible for the formulation of appropriate legislation.

Furthermore, a programme for testing the performance of three different dosimetry systems has been initiated to prove the adequacy of the recommendations prescribed in the document. The results of the programme will be evaluated and reported in 1991.

2.4.3. Dosimetry of Beta and Low-Energy Photon Radiations

The group participates in a coordinated joint CEC research project aimed at overcoming a number of difficulties in the dosimetry of weakly penetrating radiations. Six laboratories are involved in the project, which has the following main objectives:

- To establish a regime for beta calibrations based on extended area sources that comply with ISO series 2 specifications;

- To study and refine extrapolation chamber measurement techniques for beta dosimetry;

- To characterize beta radiation fields in terms of the directional dose equivalent rate, $\dot{H}'(d,\alpha°)$;

- To develop and characterize thin solid state dosemeters for beta radiation;

- To develop the dosimetry of low-energy photon radiations.

In 1990, the work was concentrated on establishing the required calibration facilities and instrumentation for carrying out the experiments.

Within the framework of EURADOS-CENDOS, studies continued on the determination of dose rates from low-energy beta sources. Measurements were made at four different laboratories of the dose rates from equal Pm-147 sources. The results were compared and various uncertainty sources identified. In particular, it was found difficult to define correction factors related to variations in the environmental conditions, e.g. temperature, pressure, and relative humidity.

2.4.4. Radon Investigations

A project has been initiated on modelling of radon entry from soil into buildings. It is a part of an international collaboration, partly financed by the CEC, under the heading "Radon Sources, Models and Countermeasures".

In addition, a Ph.D. study project is in progress on modelling of radon transport through soil and into structures. It is carried out in collaboration with the Technical University of Denmark and Lawrence Berkeley Laboratory, USA.

Seasonal variations of indoor radon concentrations have been studied in a number of single-family houses with different substructures. Radon measurements have been carried out in the houses on a quarterly basis during 1990-91, and the results will be published in 1991.

2.5. Development of Instruments and Methods

2.5.1. Optically Stimulated Luminescence (OSL)

Risø's co-operation with different international laboratories on thermoluminescence (TL) research led to the development of a new method for measuring the accumulated radiation energy in materials. The method is based on Optically Stimulated Luminescence

(OSL), which most succesfully was used to stimulate environmental feldspar samples with illumination pulses from powerful infrared light emitting diodes. The new OSL method has shown advantages over the commonly used TL method as far as reproducibility and sensitivity are concerned, especially in dating archaeological and geological samples.

An add-on OSL unit was developed to be attached directly onto the glow oven of the automated Risø TL apparatus. Thirty-two IR emitting diodes are arranged in two concentric rings of 16 each, focussing at the sample. Optically stimulated luminescence is thus measured with the same PM tube as the TL measurements allowing for combined TL/OSL studies. A feedback current control that keeps the illumination constant during IR exposures was also developed. A schematic diagram of the OSL unit and its feedback control is shown in fig. 2.2.

OSL apparatus were delivered to the Nordic Laboratory for Thermoluminescence Dating, Denmark, Aberystwyth University, Wales, Institut für Strahlenschutz, Germany, and Adelaide University, Australia. Complete automated TL/OSL systems were delivered to Durham University, U.K., Delft University, The Netherlands, and Rathgen Forschungslabor, Berlin.

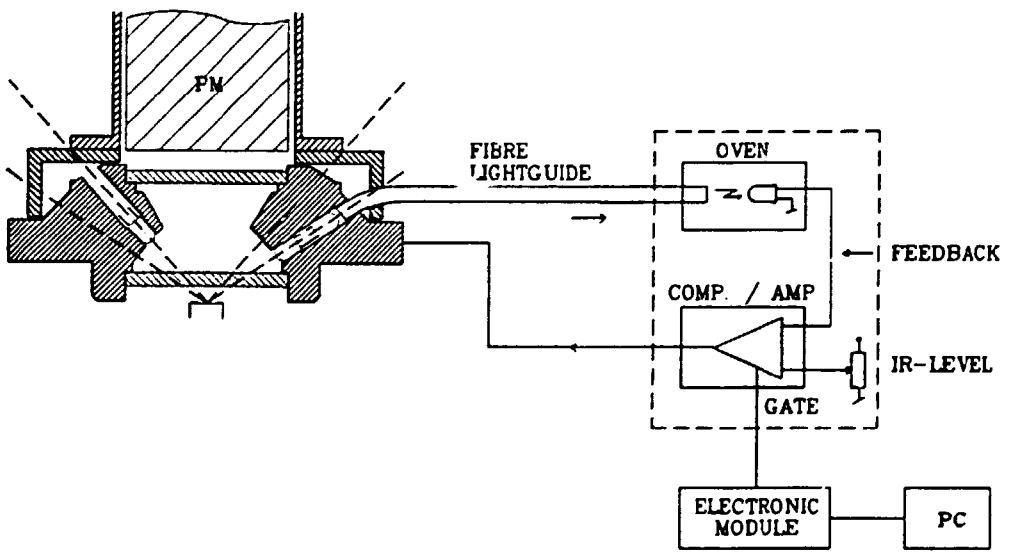

Fig. 2.2. The optically stimulated luminescence system, schematically.

2.5.2. Measurements of Environmental Gamma Radiation.

The instrument group coordinates a CEC research project aimed at testing different detector types to environmental gamma radiation and establishing practical calibration procedures. Four different European laboratories participate in the intercomparison project.

2.5.3. Multicounters

Development work continued on gas flow anticoincidence multicounters for alpha and beta counting applications. The background of the standard Risø GM-25-5 five-sample beta multicounter was improved by selecting high-purity materials and redesigning the guard counter system. The instrument background obtainable in 100 mm lead shielding and in a normal ambient radiation level is typically 0.18 cpm. The previously used electronics was replaced by a newly developed circuit plug-in board intended for installation into an IBM-compatible PC. The multicounter system is thus controlled entirely by the PC, and data including statistics are displayed on the PC monitor.

Two multicounter systems for measuring environmental beta samples were delivered to the State Institute for Radiation Hygiene, Denmark, and Institute for Energy Techniques, Norway.

2.5.4. Continuous Air Monitors

Six new Continuous Air Monitors (CAM) were developed and manufactored for the Applied Health Physics Section and put into operation at the DR 3 research reactor and Hot Cell facilities. The CAM systems contain a gas flow proportional counter built into a lead shielding. The detector faces an exchangeable filter that is placed in an air stream sucked from the environment by means of an air ejector system, driven by compressed air. Alpha and beta activities collected on the filter are recorded simultaneously on separate meters, and data are furthermore collected on an exchangeable RAM card that can display daily, weekly or monthly events on a computer screen.

2.5.5. Instrument Service

The instrument calibration service covers routine calibration and maintenance of approximately 650 health physics instruments of which approximately 50 are positioned outside Risø as part of emergency arrangements.

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Experiment in Weak Neutral Flow Conditions of Complex Terrains. Jahrestagung Kerntechnik '90, Deutsches Atomforum e.V., Nürnberg, 15th-17th May 1990.

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3. SECTION OF REACTOR PHYSICS

In the Reactor Physics Section, work is done in the following areas: 1) reactor physics research, 2) nuclear safety investigations and 3) educational activities at the DR 1 reactor.

3.1. Reactor Physics

In the field of reactor physics, some research and code development is carried out on the system of LWR codes, which are the result of many years of work.

This year, the section developed and implemented a model for taking control rod history into account in core follow studies. The neutron cross sections depend not only on whether or not the control rod is inserted, but also on the time sequence of the control rod movements in the past. This is shown in fig. 3.1, where k_∞ is indicated for a BWR assembly as function of burn up. In thin lines are shown the values one obtains in the "clean" calculations, i.e. the control rod is out all the time (BU without CR, CR out), or the control rod is in all the time (BU with CR, CR in). Two other thin-line curves are shown, obtained from the two former burn up calculations by momentarily changing the control rod positions (BU without CR, CR in) and (BU with CR, CR out). The curve drawn with a thick line shows the results obtained by simulating a given control rod sequence directly and, finally, the marks show the rather good approximation, which the model yields.

Progress was made on implementing the NEA neutron cross section library JEF-2 in reactor physics codes.

Finally, the section assisted experimenters and operators at the DR 3 reactor, especially in connection with the construction of a new facility for semiconductor irradiation. Reactor physics calculations was also made to provide safety documentation for the conversion to low-enriched uranium in DR 3.

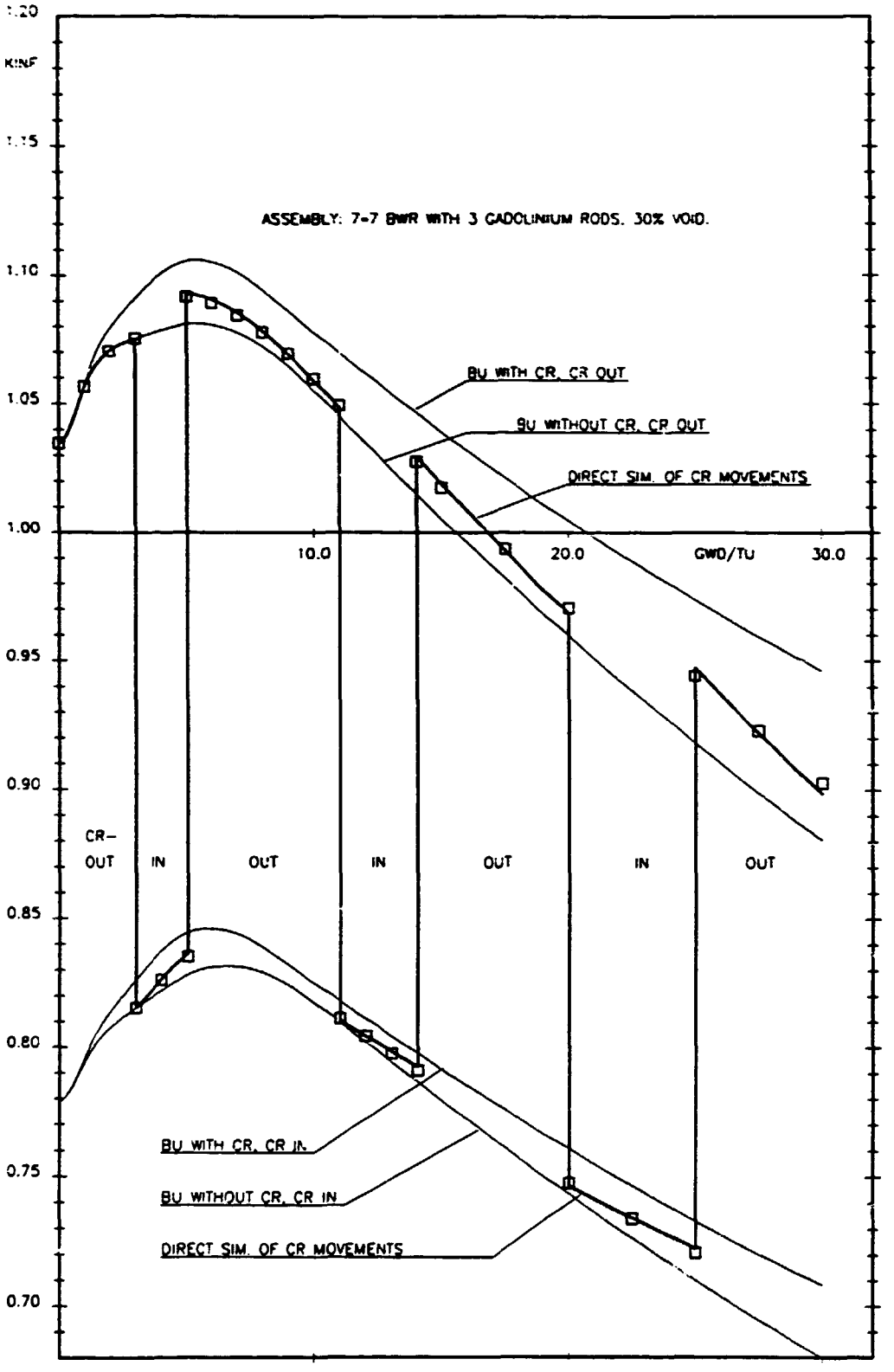

Fig. 3.1. Comparison between kinf-values obtained in a direct simulation of an assumed control rod history, and values obtained by approximative method.

3.2. Safety-related work

In 1990, three nuclear safety-related projects were started within the Nordic Committee on Safety Research (NKS). The Reactor Physics Section is involved in all these projects, SIK-1 on "Living PSA and Safety Indicators", SIK-2 on "Severe Accidents" and SIK-3 on "Safety-Related Data for Neighbour Reactors". Furthermore, the section supplies the project leader of SIK-3. All three projects run for a period of four years.

3.2.1. SIK-1

The main objective of the project is to define and demonstrate the practical use of

- Living Probabilistic Safety Assessment (LPSA), and
- Operation Safety Indicators (OSI)

in safety related decision making.

During 1990 a preproject was conducted with the aim of defining the concept of LPSA and OSI. In particular, the problems and limitations were emphasized. A survey was made of international developments and applications in this area. Furthermore, a plant-specific case study was conducted on an accident sequence for the Swedish Forsmark 3 nuclear power plant.

Finally, plans were discussed for collaborating with the Swedish utility Sydkraft to investigate methods and tools for including maintenance, inspection, and repair in the concept of LPSA and OSI.

3.2.2. SIK-2

SIK-2 on "Severe Accidents" was initiated as a preproject, which resulted in the selection of a number of tasks, e.g. "In-vessel Accident Analyses" and "Development of a Chemistry Module for the MAAP Code". Some tasks are in-kind contributions from Finnish and Swedish projects.

Risø takes part in a task considering the modelling of aerosol behaviour in accident analysis codes. Unfortunately, most codes are proprietary, which excludes Danish access to them. We are working on possible ways to solve that problem.

3.2.3. SIK-3

SIK-3 on "Safety-Related Data for Neighbouring Reactors" was started as a preproject, which was finished in September with a detailed project plan for the next four years.

The main purpose of the project is to collect, systematize, and evaluate nuclear safety related data for reactors near the borders of the Nordic countries. This information is intended for use by the authorities in the event of a nuclear accident in a neighbouring country. The information must be sufficiently detailed to make it possible to assess the course of a possible accident.

The intention is to prepare a small safety report for each of the following nuclear power plants:

- Greifswald
- Ignalina
- Kola
- Leningrad
- Stade, Brokdorf
- Brunsbüttel, Krümmel

The work will take place in co-operation with the Danish study group mentioned below.

3.2.4. Study Group for Maintaining Nuclear Knowledge

In order to maintain parts of the knowledge collected during the years of reactor research at Risø, a study group was formed of senior scientists from Risø and the Technical University of Denmark. The work was concentrated on collecting information about reactors sited close to Denmark. Members of the Reactor Physics Section have documented the Swedish BWRs Barsebäck and

Ringhals 1, and worked together with others on Swedish and German BWRs and PWRs, as well as the Greifswald reactors. Also, a description of the RBMK (Chernobyl) reactor has been made.

3.3. DR 1

The reactor DR 1 has been used for educational purposes only. A number of students from technical universities in Denmark and Sweden have carried out experiments at the reactor over periods of 1-3 weeks. 48 high school classes have carried out one-day experiments at the reactor while 180 students have carried out half-day experiments. Finally, members of the staff of DR 3 have carried out one-day brush-up experiments at the reactor.

The total number of students has been more than 1000.

List of publications

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4. THE WASTE MANAGEMENT SECTION

The waste management plant is responsible for safe handling and storage of radioactive wastes from the nuclear facilities and the laboratories at Risø as well as waste received from other Danish users of radioactive substances (laboratories, hospitals and industry). As a backup for these obligations, the staff also participates in international research projects mainly concerned with material properties and long-term behaviour of conditioned waste materials. In addition, some work on general soil chemistry is going on.

4.1. Waste Management

The operation of the radioactive waste water purification plant, the associated bituminization plant and the compaction system for low-level solid waste continued as in previous years. The total release with purified waste water to the fiord was 56 MBq (excluding tritium). This is about 0,5% of the permitted release and about 60% of that for 1989 - continuing the decreasing trend from previous years. A new controlling system for the bituminization plant is under installation. A total of 88 drums with conditioned low-level waste were produced. This is about 90% of the number typical for previous years. The drums are stored temporarily awaiting transfer to a new storage facility planned to be built in 1991. Clearing operations after the termination of work in the Risø Hot Cells resulted in storage of considerable amounts of packaged, but unconditioned α-contaminated waste in form of box-shaped waste units.

The inactive waste water purification system and the collection system for inactive chemical wastes were operated as usual. Application was made for a permit to dispose of sludges from the biological purification plant outside Risø.

4.2. Waste Material Properties Research

Work was terminated on research projects concerned with water uptake, swelling and general long-term behaviour of bitumen-or cement-conditioned low- and medium-level waste materials. These projects were initiated in the mid-eighties under the third CEC Programme on Radioactive Waste Management. A final report is available and selected results were presented in an invited summary paper to the third Luxembourg conference on Radioactive Waste Management and Disposal. Considerable improvements were obtained in understanding the long-term behaviour of cemented or bituminized materials. SANS (small angle neutron scattering) was demonstrated to be useful in studying structure of degrading cement. Continuation of the work has been accepted as a new CEC contract. The work was done in co-operation with the Chemistry Section.

Soil contaminated with radioisotopes is a special type of waste associated mainly with accidents. A scoping study was made of the possible merits of cement conditioning using a special type of additive available from the Danish firm Geodur A/S. As far as strontium and cesium are concerned, the results are not too promising, but some further studies are planned within the frame of the Nordic project KAN-2, another of the Nordic co-operative efforts mentioned in section 2.3.

4.3. Soil Chemistry

The model ECCES (Environmental Calculation of Consequences of Energy Systems) was developed during the last ten years, in the last period by the System Analysis Department. The Waste Management Section contributed to the development with know-how concerning soil chemistry.

An example of the use of the model was published in 1990 as a conference paper, and a final report was prepared on a project concerning the validation of the model by means of field data for forest soils. In general, the results from the validation were

reasonable although some weaknesses in the model were pointed out. The project was carried out in co-operation with the Danish Forest Experiment-Station and the Danish National Environmental Research Institute and was financed by the Ministry of Energy. The System Analysis Department has now concluded further work on the model. However, the Waste Management Section operates a PC-version of the soil chemistry module as applied to a single multi-layered area covered by trees or other plants.

List of publications

BRODERSEN, K., LUNDGAARD, T. Driftsrapport for Behandlingsstationen med tilhørende lagre. Perioden 1/1-31/12-1990 (in Danish).

BRODERSEN, K., NILSSON, K. Mechanisms and Interaction Phenomena Influencing Releases in Low- and Medium-Level Waste Disposal Systems. Final Report 1986-1990. Risø-M-2908. Nov. 1990.

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BRODERSEN, K., VINTHER, A. Characterization of Waste Products Prepared from Radioactive Contaminated Clayey Soil Cemented According to the Geodur Method. Risø-M-2909. Nov. 1990.

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in: Juha Kämäri, ed. Impact Models to Assess Regional Acidification. IIASA - Kluwer Academic Publishers, 1990.

BRODERSEN, K., BILLE-HANSEN, J., JØRGENSEN, K.H., HOVMAND, M.F., CHRISTIANSEN, H., MACKENZIE, G.A., SOLGAARD, P. Data Acquisition and Application of the ECCES model to Forest Soil. Risø-M-2843, Dec. 1990.

Appendix 1

STAFF OF THE DEPARTMENT 1990

Department Management

Bjarne Micheelsen (head up to his dead 1990-08-22)
Frits Heikel Vinther (acting head)

Lis Rasmussen

Section of Health Physics
(incl. scientists in the Section of Applied Health Physics)

Frits Heikel Vinther (head)
Claus Erik Andersen
Lars Bøtter-Jensen
Per Hedemann Jensen (head SAHP)
Bente Lauridsen (SAHP)
Poul Christensen
Jørgen Lippert
Benny Majborn
Flemming K. Nielsen
Jens Søgaard-Hansen (SAHP)
Søren Thykier-Nielsen
Ole Walmod-Larsen
Lisbeth Warming (SAHP)

Birthe Berg
Per Brøns
H.E. Christiansen
Lissi Sture Hansen
Jørgen Jakobsen
Nina Jensen
Johannes Jepsen
Finn Jørgensen
Berit Kornerup

Ingrid Kristensen
Rolf Lange
Margit Nielsen
Jette Olsson
Finn Pedersen
Jørgen Rabe
Joaquin Roig
Lis Sørensen
Finn Willumsen

Reactor Physics

C.F. Højerup (head)
P.E. Becher
Peter Bille Fynbo
Erik Nonbøl
Jørgen Olsen
Knud Ladekarl Thomsen

Inge Blyitgen
Ejnar Danielsen

Waste Management Section

Knud Brodersen (head)
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Winnie Andersen
Erling Christenen
Birthe Hansen
Signe Hansen
Ole Sølling Hansen
Sven Jensen
Gitte Larsen
Jørgen Larsen
Knud Larsen
Bent Nielsen

Palle Olson

Jesper Bohn Rasmussen

Nina Thomsen

Bent Willumsen

Arne Vinther

Ruth Aagesen

Appendix 2

PARTICIPATION IN INTERNATIONAL
WORKING GROUPS, ETC.

IAEA, The International Atomic Energy Agency

Co-ordinated Research Programme on Intercomparison for Individual Monitoring (Christensen).

International Chernobyl Project, TASK 5 (Hedemann Jensen, task leader).

ICRP, International Commission on Radiological Protection

Committee 4, Application of the Recommendations (Gjørup).

OECD, Nuclear Energy Agency

Committee on Radiation Protection and Public Health (Hedemann Jensen).

CSNI, Steering Committee (Højerup).

CSNI, PWG4, Confinement of Accidental Radioactive Releases (Fynbo).

CSNI-PWG4, Subgroup of Experts on Accident Consequences (Thykier-Nielsen).

NEA-Databank, Steering Committee (Højerup).

NEA-CRP, Committee on Reactor Physics (Nonbøl).

CEC, Commission of the European Communities

Article 31 Group of Experts (Gjørup).

Article 37 Group of Experts (Walmod-Larsen).

CGC 6 Nuclear Fuel Cycle (Brodersen).

ACPM for Plan of Action (Brodersen).

Task 3 of the Waste Research Programme (Brodersen).

Working Party on Criteria for Recycling Materials from the Dismantling of Nuclear Installations (Heikel Vinther).

Working Group on Reactor Dosimetry (Olsen).

Group of National Experts on Assistance in the Event of a Nuclear Accident or Radiological Emergency (Heikel Vinther).

Expert Group of Safety and Environment for the European Fusion Programme (Warming).

Expert Group on Environmental Gamma Monitors (Bøtter-Jensen).

Expert Group on Transfrontier Emergency Planning (Walmod-Larsen).

Group of Technical Experts on Radiation Protection Dosimetry (Christensen and Majborn).

EURADOS-CENDOS, Skin Dosimetry (Christensen - Chairman).

EURADOS-CENDOS, Criticality Accident Dosimetry (Majborn).

EAES, European Atomic Energy Society

Public Relations Correspondents Group (Walmod-Larsen).

Nordic Cooperation

Steering Committee for NKS Projects (Heikel Vinther).

Reference Group on KAN Projects (Brodersen).

Editorial Boards

Radiation Protection Dosimetry (Bøtter-Jensen).

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Lists of staff and publications are included together with a summary of participation in international working groups etc.

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